

INTRODUCTION

BIOMEDICAL AND ENVIRONMENTAL RESEARCH PROGRAM

Lawrence Livermore Laboratory

University of California

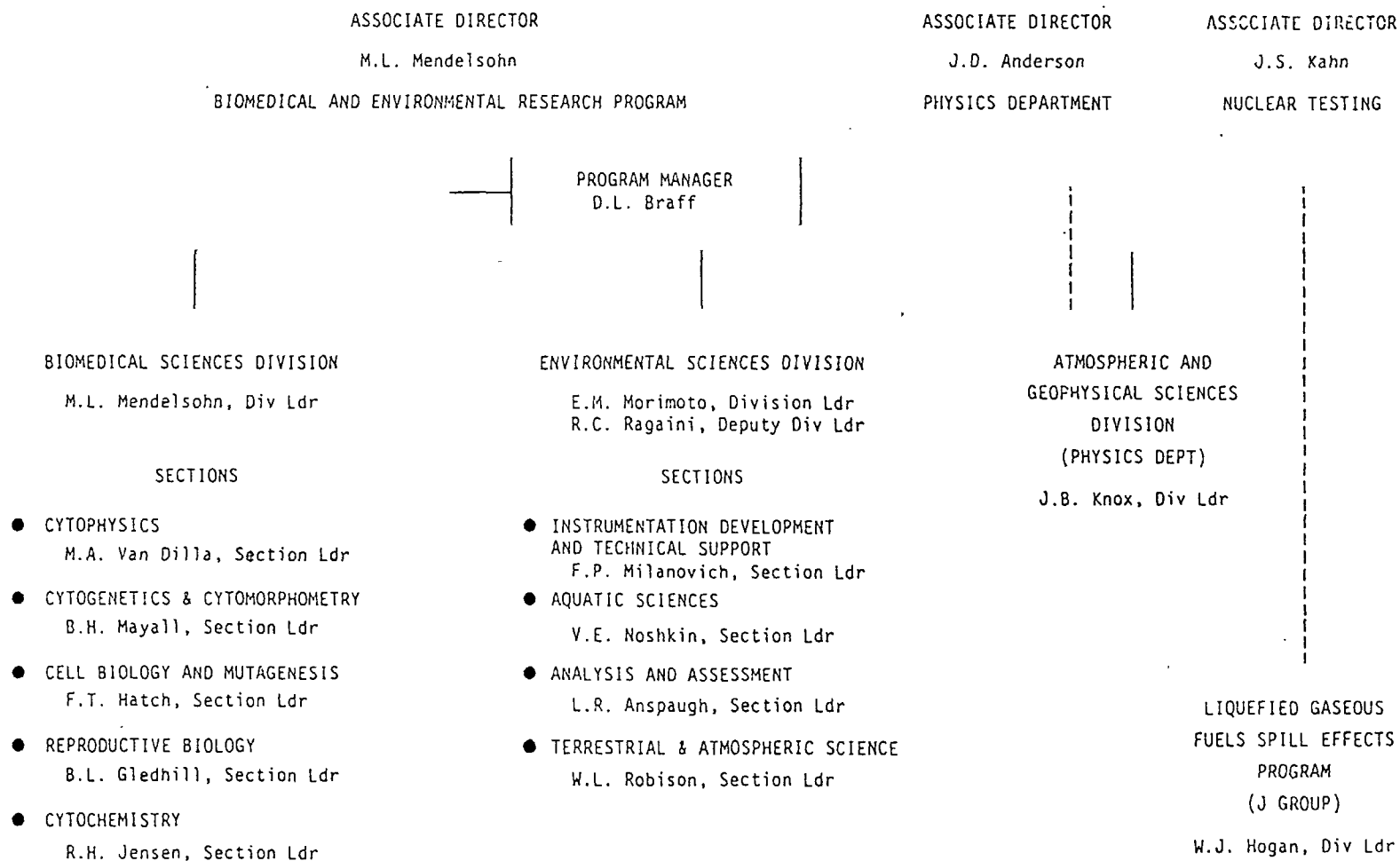
Livermore, California 94550

The mission of the Biomedical and Environmental Research Program at Livermore is an improved understanding of the implications to man and his environment of energy development and consumption. This embraces laboratory, field and analysis activities covering fundamental mechanism, phenomenology, socioeconomic effects, strategies for control and safety, and comprehensive assessment. The focus is increasingly on specific energy technologies and the goal is to develop sufficiently broad understanding to predict and modulate the impact on society of available energy options.

The bulk of the Program is divided into four organizational structures: the Biomedical Sciences Division, the Environmental Sciences Division, the Atmospheric and Geophysical Sciences Division within the Physics Department, and the Liquefied Gaseous Fuels Spill Effects Program within the Nuclear Testing Program. ASEV related efforts are also funded or proposed from the Hazards Control Department, Earth Sciences Division, Mechanical Engineering Department and Chemistry Department.

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Organization of the Biomedical and Environmental Research Program *



* Not shown are additional ASEV-related efforts funded or proposed from Hazards Control Department, Earth Sciences Division, Mechanical Engineering Department, and Chemistry Department.

BIOMEDICAL AND ENVIRONMENTAL SCIENCES DIVISIONS

Organization

These two Divisions function with common administrative staff, support functions and facilities within the Biomedical and Environmental Research Program.

The Biomedical Sciences Division deals with the mechanism, detection and minimization of potential long-term health impacts, with primary emphasis on mutagenic, carcinogenic and reproductive biologic effects, and on analytical cytology as a tool for analysis of such effects.

Mutagenesis and carcinogenesis are probably the most sensitive and important deleterious health effects of concern to DOE. They involve long latent periods and profound consequences, and they operate through a multitude of physical and chemical mechanisms. To understand and ameliorate such effects requires a thorough knowledge of genetics and cancer biology, the development of tools to detect mutagenesis and incipient carcinogenesis in man, and the large-scale application of these advances to occupational medicine and human epidemiology. Current LLL efforts emphasize two approaches: 1) reliable, sensitive assays for specific toxic substances using animal, cellular and microbial systems; and 2) detection methods that can indicate mutagenic and early, reversible carcinogenic changes in readily obtainable samples of blood and urine from individual people.

The reproductive system is crucial for perpetuation of the species and is exquisitely responsive to toxicologic damage. Current LLL studies indicate that rodent and monkey oocytes at one stage of development are the most sensitive cells in the body to radiation and to certain energy-related chemicals. Spermatogenesis remains highly vulnerable throughout adult life and our studies show that in animals and man it provides an important assay for mutagenic and other toxicologic activity. Continuing research in these two gametogenic systems deals with mechanism of effect, dose-response relationships, species differences including primates and man, and broad application as potential monitoring systems.

Analytical cytology is the science and technology of probing cells for their physical, morphological, chemical and functional properties. At LLL emphasis is placed on two complementary approaches: 1) cell measurements and sorting by flow cytometry, and 2) cell measurement and discrimination by scanning microscopy and computer-based image analysis. These approaches offer high resolution, quantitation and automated high-capacity processing and have been coupled to a rich, rapidly growing diversity of cytochemical cellular probes. They are being applied to cancer diagnosis, to chromosome analysis, to sperm analysis, and to identifying somatic mutations as rare, highly specific events in single cells.

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The application of these studies to energy technologies includes toxicologic assay of effluents from oil shale retorting and in situ coal conversion, radiation effects of tritium, testing of workers in the petrochemical industry, toxicology of methanol, and a variety of analyses of specific chemical and physical agents.

Significant accomplishments in FY 1979 and their projection to FY 1982 include:

- Through a consortium of research projects a battery of bacterial, mammalian cellular, and whole animal bioassays for genetic toxicity is being applied to effluents from in situ coal gasification and oil shale retorting. Neutral and basic organic constituents are moderately mutagenic in bacteria, but in preliminary experiments appear much less toxic in higher organisms. These studies will help to ensure the safe development of advanced fossil energy technologies.
- A cellular specific-locus method for measuring somatic mutation frequencies in humans is progressing rapidly. Fluorescent antibodies are used to label rare red blood cells containing de novo abnormalities of hemoglobin, such as sickle hemoglobin. The test is potentially a biological dosimeter for a variety of highly specific genetic lesions. It may determine the risk of cancer individuals, the damage incurred by an accidental, occupational or environmental exposure, and the presence of genetic susceptibility to mutagenesis.
- A set of mutant Chinese hamster cell lines that are unusually sensitive to toxic and mutagenic effects has been developed. Each mutant is specifically sensitive to a class of mutagens and appears to be defective in a particular mechanism of DNA repair. The battery of mutants offers the possibility of rapid and inexpensive mammalian screening for mutagens and of defining and currently unknown steps in DNA repair in mammals.
- Certain chemicals act like radiation in killing female germ cells in mice. By giving the chemicals and radiation both together and separately, we found their effects are additive, which suggests they may damage the ovary in the same way. This finding advances our understanding of how environmental toxic chemicals may effect us.
- The DNA content of sperm from mice exposed to x-rays or the mutagenic chemical, methyl methanesulfonate, has been measured in a flow cytometer equipped with a specially designed sample chamber in which hydrodynamic forces accurately orient the flat sperm heads and eliminate orientation artefact. A positive correlation between dose and variability in individual sperm DNA content was shown, and also a highly significant correlation between percent of

misshapen sperm and variability in DNA content. These experiments demonstrate for the first time the potential utility of sperm DNA measurements to monitor for chemical and physical genetic toxins in mammals including man.

- Fifty men who worked in a pesticide production plant with carbaryl were shown to have more semen defects than men in a new-hire control group. In addition, cancer chemotherapeutic drugs were shown to induce sperm defects. Sperm morphology and counts were found to be sensitive indicators of chemical exposure. These studies are part of the validation phase to determine whether sperm defects in man can be used to quantitate chemical exposure.
- Considerable mutagen detectable with a bacterial assay is formed during the grilling of ground beef to a well-done, but non-charred state. This mutagen appears to be formed from free amino acids of fragments of protein molecules and not from intact protein. However, preliminary results with mammalian bioassays indicate much smaller effects of the mutagen in higher organisms. These studies will allow estimation of potential hazard to the population from common cooking processes and design of preventive measures based on thorough knowledge of mechanisms.
- Activation with specifically induced rodent metabolizing liver enzymes (cytochrome P-450's) was found necessary for cooked beef extracts to cause bacterial mutations. Best induction was with PCB's, a common terrestrial and aquatic pollutant, and polycyclic aromatic hydrocarbons, common to cigarette smoke, barbecued foods and polluted air. The induction specificity of the liver enzymes has been used to help identify the active compounds in cooked beef extracts. Mutagen-activating enzymes from the intestine were also increased by the inducers and natural flavones, common in the human diet, gave the biggest effect. Since the frequency of human cancer of the G.I. tract is rising and man does ingest both cooked beef and the flavones, it is plausible that activation needed for mutagenicity/carcinogenicity could occur in the human intestine.
- A flow cytometric method for measuring the cell cycle kinetic properties of the stem cells of the intestinal epithelium was developed. This will allow study of the response of these cells to chemotherapeutic agents and the minimization of damage to this important normal tissue during cancer chemotherapy.
- Groups of rats are being induced to develop bladder cancer slowly over a year's period. Cancer cells at many stages in neoplastic transformation are obtained by surgically removing the lesions from the appropriate rat. This is an excellent model for studying the cell biology of neoplastic transformation, and for research on early diagnosis of bladder cancer in humans.

- A blood test was developed to measure the amount of cathepsin, a proteolytic enzyme, in serum. The level of enzyme activity appears to be an early indication of cervical cancer in women. The test may be an adjunct to the present Pap smear as a means to screen females for early signs of cancer.
- We have implemented computer-controlled, eight-variable cell sorting on a dual-beam sorter. Utilizing two laser beams and a multivariable pulse-height analyzer, cells and chromosomes can be analyzed for several components or properties and sorted based on any combination of the measurements. An important application is the improved resolution of individual chromosome types from human cells, allowing better chromosome purification for biomedical studies.
- A slit scanning flow cytometer has been constructed which allow high speed measurement of the distribution of dye along cells and chromosomes with a spatial resolution of less than $1\mu\text{m}$. Chromosomes and cells can be classified on the basis of their slit scan profiles. The device is especially useful in detecting aberrant cells or chromosomes which may occur as a result of mutagen exposure.
- Assignment of human B-, γ -, and δ -globin genes to the short arm of chromosome 11 by chromosome sorting and DNA restriction enzyme analysis was accomplished, thus demonstrating a new technique based on flow sorting to assign genes to the chromosomes of the human karyotype.
- The composition of histones, the major proteins binding DNA into the subunit structure of chromatin, has been found to be different in heterochromatin and potentially active chromatin. This lends support to the idea that histones and related proteins may regulate the level of genetic activity of chromatin regions by affecting the condensation states of the chromatin.

The Environmental Sciences Division effort is directed toward furthering the understanding of the health, environmental, and societal consequences of energy-related activities. The scope includes aquatic and terrestrial ecology, studies of physical, chemical and biological processes, identification and characterization of pollutants, evaluations of control and mitigation measures, development of instrumentation, and assessments of energy-related impacts.

Related to nuclear energy, the studies concentrate on the transport and long-term environmental behavior of plutonium and other selected radionuclides. Included are studies of the coastal and oceanic behavior of radionuclides, of their uptake and transfer through food pathways, of their biogeochemical cycling, and of the several radiological exposure pathways to man. The investigations, along with related monitoring activities, are being carried out in the Pacific and Atlantic Oceans, the Marshall Islands, the Nevada Test Site, and the environment of nuclear installations. In support of these efforts, measurement and monitoring instrumentation is being developed. Information derived from these activities and the available literature is used in preparing evaluations of potential radiological doses and recommendations for mitigation measures.

In nonnuclear energy areas, similarly integrated approaches toward source terms, pathways, dosimetry, and assessment are being applied to a wide spectrum of problems. These activities include identification and characterization of effluents from direct combustion of coal and in situ conversion of coal and oil shale, studies of the transfer of contaminants through food pathways, identification of mechanisms and diagnostics for pollutant impacts on plants and plant ecosystems, investigation of the ecological effects of off-shore petroleum exploitation, monitoring and studies of the atmosphere, water quality, and ecosystems at geothermal and fossil-fuel development sites, and various problems in assessment and evaluation of the consequences of energy-related activities.

Of major importance are the integrated environmental assessments of radiological dose commitments attendant to rehabilitation of the Marshall Islands. Other comprehensive integrated assessments are being extended to in situ fossil fuel and other nuclear and geothermal sites.

Significant accomplishments planned for Fiscal Years 1980 through 1982 include:

Fiscal Year 1980

- Completion of preliminary assessment activities for high priority Known Geothermal Resource Areas.

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- Completion of assessment of generic environmental impacts of geopressured energy.
- Completion of study of land-use impacts of geothermal resource development at the Geysers.
- Completion of comprehensive assessment of environmental control technologies applicable to proposed geothermal energy systems in the Imperial Valley.
- Completion of assessment of radiological consequences of resettlement of northern half of Enewetak Atoll after clean up.
- Completion of radiological analyses of samples taken from 13 atolls studied in the Northern Marshall Islands Multi-Atoll Survey.
- Completion of miniaturized CO₂ sensor system development.

Fiscal Year 1981

- Commercialization of "Transuranic Aerosol Monitoring System".
- Final summary assessment of all 13 atolls studied in the Northern Marshall Islands Multi-Atoll Survey.
- Environmental Development Plan for "Hot Dry Rock" geothermal development.
- Environmental Readiness Document for geopressure development.
- Conduct an environmental assessment of hydrothermal direct-use effects.
- Provide the first Annual Health and Environment Effects Assessment for Geothermal Energy Development.

Fiscal Year 1982

- Completion of assessment of the environmental and human health consequences of heavy oil extraction in California and other western states.
- Completion of assessment of impact of emissions of projected commercial oil shale industry on air quality in the Piceance Basin.
- Reappraisal of potential environmental control technologies for underground coal gasification.
- Provide the Second Annual Health and Environmental Effects Assessment for Geothermal Energy Development.

Supplemental Funding

The following is a list of funding periods and total (direct plus overhead) funding for all grants, interagency agreements and "work for others" agreements that were in effect in FY 1980.

- (1) National Cancer Institute -- USPHS Grant No. 5 R01 CA 14533:
"Radiobiological Techniques in Human Cancer Therapy"
Principal Investigator: Mortimer L. Mendelsohn
9/1/77 - 8/31/78 \$256,606
9/1/78 - 2/29/80 \$415,746
3/1/80 - 2/28/81 \$289,516 (pending approval)
- (2) National Cancer Institute -- Interagency Agreement Y01-CB-40300:
"Stain and Optical Markers for Cytopathology"
Principal Investigator: Brian H. Mayall
6/30/77 - 6/29/78 \$390,486
6/30/78 - 6/29/79 \$292,041
6/30/79 - 6/29/80 \$346,426 (Terminal year)
- (3) National Heart, Lung and Blood Institute -- USPHS Grant No. 1 R01 HL 23747: "Heterogeneity and Properties of Plasma Lipoproteins"
Principal Investigator: Virgie Shore
7/1/79 - 6/30/80 \$142,810
- (4) DOE/EPA Pass-Through Projects:
 - (a) "Baseline Data on Benthic Community Structure in the Santa Barbara Channel Oil Lease Area and the Effects of Drilling Muds on Offshore Benthos"
Principal Investigator: Robert Spies
9/15/77 - 9/14/78 \$ 70,000
9/15/78 - 9/14/79 \$120,000
9/15/79 - 9/14/80 \$120,000
 - (b) Quantitative Mutagenesis Testing in Mammalian Cellular Systems:
Principal Investigator: Frederick T. Hatch and June Carver
9/15/77 - 9/14/78 \$150,000
9/15/78 - 9/14/79 \$150,000
9/15/79 - 9/14/80 \$135,000
 - (c) "Morphologic Variants in Damaged Sperm"
Principal Investigator: Andrew Wyrobek
9/15/77 - 9/14/78 \$ 60,000
9/15/78 - 9/14/79 \$ 60,000
9/15/79 - 9/14/80 \$ 60,000
 - (d) "The Mouse Oocyte System as a Monitor of Chemical Toxicity"
Principal Investigator: R. Lowry Dobson
9/15/77 - 9/14/78 \$ 75,000
9/15/78 - 9/14/79 \$ 75,000
9/15/79 - 9/14/80 \$ 75,000

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- (5) Office of Nuclear Regulatory Research SAFER -- Orders #60-78-260 and #60-79-022
"Chemical Effluents from Nuclear Power Plants"
Principal Investigator: Florence L. Harrison
10/1/77 - 9/30/78 \$214,000
9/1/78 - 9/30/79 \$ 32,000
10/1/78 - 9/30/79 \$128,000
10/1/79 - 9/30/80 \$100,000
- (6) National Institute of Environmental Health Sciences - Interagency Agreement
"Cytophysical Studies in Mutagenesis"
Principal Investigator: Mortimer L. Mendelsohn
10/1/77 - 9/30/78 \$230,000
10/1/78 - 9/30/79 \$417,000
10/1/79 - 9/30/80 \$325,000
- (7) National Institute of General Medical Sciences - USPHS Grant No. RO1 GM25076
"Chromosomal Flow Cytometry: DNA and Centromeres"
Principal Investigator: Marvin A. Van Dilla
4/1/78 - 3/31/79 \$144,710
4/1/79 - 3/31/80 \$ 80,905
4/1/80 - 3/31/81 \$206,239 (pending approval)
- (8) NIH-Institutional National Research Service Award -- USPHS Grant Numbers 5 T32 HL07058 and 1 T32 CA09133.
This program provides three Postdoctoral trainee positions for a period of four to five years. Two positions are in the field of "Nutrition in Heart and Vascular Disease"; the positions are filled by Gary Ott and Mason Shen. One position in the field of "Cell Kinetics" is filled by Stephen C. Macevicz.
- (9) Department of the Army -- #W43P6S-78-8027 & ASL 79-8002
"Navy Wedge - Phase II"
Principal Investigator: G. E. Bingham
3/1/78 - 1/31/79 \$ 68,000
10/1/78 - 9/30/79 \$ 25,000
10/1/79 - 9/30/80 \$ 65,000
- (10) National Aeronautics & Space Administration-JPL-DPR WO-8026
"Silicon Analysis Studies"
Principal Investigator: R. E. Heft/R. C. Ragaini
1/31/78 - 2/1/79 \$ 85,000
2/01/79 - 9/30/79 \$ 71,000
10/01/79 - 9/30/80 \$100,000 (pending)
- (11) National Bladder Cancer Project -- USPHS Grant No. 1 R26CA2379.
"Cytochemical Probes of Urothelial Tumor Cells"
Principal Investigator: M. A. Vanderlaan
9/1/78 - 8/31/79 \$103,803
9/1/79 - 8/31/80 \$109,906
9/1/80 - 8/31/81 \$251,471 (pending approval)

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- (12) National Institute of Environmental Health Sciences -- Interagency Agreement 22Y01-ES-80038
"Mutagens, Cooking of Food"
Principal Investigator: F. T. Hatch
10/1/78 - 9/30/79 \$400,000
10/1/79 - 3/31/80 \$200,000
4/1/80 - 9/30/80 \$200,000
- (13) National Institute of Environmental Health Sciences -- Interagency Agreement 22Y01-ES-80040
"Tracheal Epithelial Cells"
Principal Investigator: M. A. Vanderlaan
10/1/78 - 9/30/79 \$ 50,000
10/1/79 - 9/30/80 \$ 60,000
- (14) Fish & Wildlife Service -- Cooperative Agreement FWS 14-16-0009-78-969
"Modeling Effects of Air Pollution (SO₂) on Wildlife Habitat"
Principal Investigator: J. R. Kercher
10/1/78 - 9/30/79 \$ 80,000
10/1/79 - 5/31/80 \$ 26,880
- (15) Nevada Operations Office --
"NAEG-Pu Studies"
Principal Investigator: J. H. Shinn
10/1/78 - 9/30/79 \$ 11,000
10/1/79 - 9/30/80 \$ 40,000
- (16) The following 7 projects were transferred from DOE to EPA:
- (a) "Sperm as Indicators of Hazard" ID# RPIS 254
Principal Investigator: B. L. Gledhill
10/1/78 - 9/30/79 \$139,000
10/1/79 - 9/30/80 \$139,000
- (b) "Automatic Cytologic Methods for Monitoring Genetic Injury in Humans" ID# RPIS 2632
Principal Investigator: E. W. Branscomb
10/1/78 - 9/30/79 \$ 77,000
10/1/79 - 9/30/80 \$ 77,000
- (c) "Fate and Effects of Petroleum Hydrocarbons in the California Coastal Environment" ID# RPIS 4040
Principal Investigator: R. E. Spies
10/1/78 - 9/30/79 \$ 83,000
10/1/79 - 9/30/80 \$ 83,000
- (d) "Program Coordination (MAP3S)" ID# RPIS 002343
Principal Investigator: M. McCracken
10/1/78 - 9/30/79 \$118,000 (terminal year)

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- (e) "Heavy Metal Methylation and Mutagenesis" ID# RPIS 1952
Principal Investigator: R. T. Taylor
10/1/78 - 9/30/79 \$150,000
10/1/79 - 9/30/80 \$150,000
- (f) "Theoretical Approach to Assessment of Pollutant Stress on
Plant Function" ID# RPIS 699
Principal Investigator: J. Shinn
10/1/78 - 9/30/79 \$405,000
10/1/79 - 9/30/80 \$405,000
- (g) "Cytochemical Markers for Cell Transformation and Carcinogenesis"
ID# RPIS 002630
Principal Investigator: M. Vanderlaan
10/1/78 - 9/30/79 \$206,000
10/1/79 - 9/30/80 \$206,000
- (17) National Institute of Environmental Health Sciences -
Interagency Agreement ES-80035
"Carcinogenic/Noncarcinogenic Paired Compounds"
Principal Investigator: A. J. Wyrobek
2/1/79 - 10/1/79 \$ 14,750 (terminal year)
- (18) Department of Agriculture - 53-9AHZ-8-1442
"Genetic Toxicology of Quercetin"
Principal Investigator: A. V. Carrano
2/1/79 - 8/31/79 \$ 10,500
9/1/79 - 8/31/80 \$ 30,200
- (19) SAN - Intraoffice Transfer - 82-02B&R
"GLGP Environmental Assistance"
Principal Investigator - L.R. Anspaugh
2/1/79 - 9/30/80 \$ 70,000
- (20) National Institute of General Medical Sciences
"A Solid State Automated Microscope"
Principal Investigator: I. T. Young
4/1/79 - 3/31/80 \$130,144
4/1/80 - 3/31/81 \$197,784 (pending approval)
- (21) Environmental Protection Agency Agreement 79-D-X0826, "Study to
Investigate the Relationship of Lead Exposure to Semen Abnormalities"
Principal Investigator: A. J. Wyrobek
9/1/79 - 8/31/80 \$ 59,080 + (\$39,386 pending)
- (22) Environmental Protection Agency; Order #C3305NANX
"Mice Exposed to Diesel Exhaust"
Principal Investigator: A. J. Wyrobek
9/14/79 - 9/13/80 \$ 13,500
- (23) DOE-Economic Regulatory Administration and California Public
Utilities Commission
"Assessment of 230KV Transmission Line"
Principal Investigator: D. W. Layton
DOE/ERA Funding:
9/1/79 - 9/30/79 \$ 4,500
10/1/79 - 9/30/80 \$ 33,000

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PUC Funding

10/1/79 - 9/30/80 \$ 37,500

- (24) Nevada Operations Office
"Calculation of Off-site Radiation Doses from Nuclear Testing in Nevada"
Principal Investigator: L. R. Anspaugh
10/1/79 - 9/30/80 \$100,000 + (\$260,000 pending)
- (25) National Heart, Lung and Blood Institute - USPHS Grant
1 R01 HL24740-1 - LBL/LLL collaborative study
"Dietary Effects of Serum High Density Lipoproteins"
Principal Investigator: R. M. Krauss - LBL
Co-Investigator: V. G. Shore - LLL
8/1/79 - 7/31/80 \$ 69,066 (LLL portion)

Biomedical and Environmental Sciences Divisions

ARRIVALS

Richard T. Cederwall, M.S., formerly a Meteorology Associate, Brookhaven National Laboratory, Upton, New York, assigned to the Terrestrial and Atmospheric Sciences Section, Environmental Sciences Division.

Jeffrey I. Daniels, M.S., University of California, Los Angeles, California, assigned to the Analysis and Assessment Section, Environmental Sciences Division.

Susan K. Healy, M.S., formerly a research scientist on contract with Staff Builders, transferred to the Biomedical Sciences Division, LLL. She is working on the NIEHS Food Mutagen Project doing Salmonella mutagenesis assays.

Tomas Hirschfeld, Ph.D., formerly at Block Instruments Laboratory, now part-time in the Biomedical Sciences Division functioning as a general consultant in areas of spectroscopy, instrumentation and analytical cytology.

Douglas J. Ng, B.S., transferred from Post College Appointment Program, LLL, Livermore, California, assigned to the Instrumentation Development and Technical Support Section, Environmental Sciences Division.

Dennis S. Orwig, B.A., formerly a graduate student at the University of Washington, Biochemistry Department. He is working in carcinogen metabolism in the Biomedical Sciences Division, LLL.

Edmund P. Salazar, B.S., transferred from Post College Appointment Program, LLL, assigned to the Cell Biology Section of the Biomedical Sciences Division.

Nancy Shen, M.S., is carrying out chemical, electrophoretic, and isoelectric focusing analyses of plasma lipoproteins, proteins, and membrane components. These analyses are part of the overall studies on the structural expression of genetic variants and physiological consequences of the variation.

DEPARTURES

Beverly Berger, resigned from the laboratory and took a position with the Department of Energy.

Elliot Bogart, resigned from the laboratory. Accepted a position at TRW in McLean, Virginia.

Patrick Coyne, resigned from the laboratory and took a position with the U.S. Department of Agriculture, Woodward, Oklahoma. He is currently a consultant to Environmental Sciences Division.

Donald Ermak, transferred to "L" Division, LLL.

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DEPARTURES (continued)

Susan Fong, resigned from the laboratory and took a position with Cetus Corporation in Berkeley, California, where she is working as a cell culture technician.

Paul Hara, resigned from the laboratory to pursue a hobby in filmmaking.

Robert Hung, resigned from the laboratory and is currently a consultant to Environmental Sciences Division.

Marla Moody, resigned from the laboratory and took a position with Rio Blanco Oil Shale Company, Denver, Colorado.

Larry Scherr, completed his doctoral work at the laboratory and took a position at the City of Hope Medical Center in Duarte, California.

William Steele, transferred to Chemistry and Materials Science Department, LLL.

Tore Straume, accepted a position in the Hazards Control Department, LLL, as a Health Physicist. He continues as a graduate student working with R. Lowry Dobson.

Gary Tompkins, resigned from the laboratory to pursue a consulting career.

Daniel Wandres, resigned from the laboratory to continue his education.

GRADUATE STUDENTS

Helen Buckholtz, (Department of Applied Science, University of California, Davis, California) is being supervised by Dr. Lynn Anspaugh and Dr. Wilson Talley (UC Davis) in her work on particle transport and coagulation in power plant plumes.

Richard Davis, (University of California, Berkeley, California) Biophysics Group, is being supervised by Dr. Anthony Carrano in his work on DNA damage and repair in heterochromatin and euchromatin.

John Knezovich, (Department of Food Sciences, University of California, Davis, California) is being supervised by Dr. Florence Harrison and Dr. Gerald F. Russell (UC Davis) in his work on the effect of copper on different life stages of the freshwater clam *Corbicula manillensis*.

Richard Peverini, (Department of Applied Science, University of California, Davis, California) is being supervised by Dr. Ian T. Young in his work in computer sciences.

Susan Sweigart, (University of California, Berkeley, California) Biophysics Group, is being supervised by Dr. Anthony Carrano in her work on DNA alkylation and sister chromatid exchange.

Tore Straume, (University of California, Davis, Ca.) Biophysics Group is being supervised by R. Lowry Dobson on effects of neutrons on mouse irradiation oocytes.

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POSTDOCTORAL FELLOWS

Gary Ott, an NIH postdoctoral fellow, is developing experimental techniques for analyzing the heterogeneity of the major classes of plasma lipoproteins and the microheterogeneity of proteins. These techniques, together with other procedures, will be used to analyze variants, either genetic or pathological among selected human subjects.

Stephen Macevicz, an NIH postdoctoral fellow, is developing experimental and mathematical techniques for the flow cytometric study of the effect of cytosine arabinoside (ara-C) on cell cycle traverse. Experimental studies will be carried out in vitro and in vivo on Lewis lung tumor cells. He will adapt an existing model of cell cycle traverse to account for the time dependent cell cycle perturbations produced by a pulse of ara-C.

Mason Shen, an NIH postdoctoral fellow, is collaborating on characterization of lipoprotein subfractions that are being used in studies on their modulating effects on immune functions. He is also participating in studies on the effects of diet on lipoprotein properties and function.

SUMMER INSTITUTE - A program to bring faculty from minority colleges and universities to the laboratory for eight weeks of training and research.

Bessie Foster, (Grambling State University) worked on antinucleoside stains of tumor cells.

Jerry L. Johnson, (University of Hawaii, Hilo) worked on environmental impact studies at the geysers.

Altaf Rahman, (South Carolina State University) worked on developing new fluorescent tags for cytoenzymological techniques.

AFFIRMATIVE ACTION PROGRAMS

COOP - is a program sponsored by the Office of Equal Opportunity for college students in science and engineering majors wherein they work for six months full-time and are in school for six months. Participants in our laboratories include:

John Ross

OJT - (On-the-Job-Training) is to provide laboratory-relevant work experience to individuals who are economically disadvantaged and have few or no marketable skills for non-professional LLL positions. Participants in our laboratories include:

Debra Caldeira

AFFIRMATIVE ACTION PROGRAMS - continued

STEP - (Student Technology Experience Program) is to provide high school and college students with meaningful work experience and encouragement from their supervisors to continue their education in a scientific, engineering, or business curriculum beyond high school. Participants in our laboratories include:

Gabriella Bataglia	Giselle Honore	Timothy Rodrigues
Claire Dunbar	Felicia Ochoa	Annette Shaeib
Denyse Goff	Cheryl Rittman	

PCA - (Post College Appointment) is to provide lab-relevant work experience to individuals who have completed the academic requirements normally associated with professional career employment, but who lack sufficient experience to be competitive for current professional-level career positions. Participants in our laboratories include:

Michelle Corzett	Jacqueline Lam	Joe Lucas
John Hoffman	Dorothy Liu	John Poco

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